April 15, 2004

Mr. J. A. Stall
Senior Vice President, Nuclear and
Chief Nuclear Officer
Florida Power and Light Company
P.O. Box 14000
Juno Beach, Florida 33408-0420

SUBJECT: ST. LUCIE UNIT 1 - FIRST REVISED ORDER EA-03-009 RELAXATION REQUEST NOS. 1 AND 2 REGARDING EXAMINATION COVERAGE OF REACTOR PRESSURE VESSEL HEAD PENETRATION NOZZLES (TAC NOS. MBC1394 AND MC1395)

Dear Mr. Stall:

By letter dated November 21, 2003, Florida Power and Light Company (FPL) submitted two requests for relaxation from the inspection requirements of the U.S. Nuclear Regulatory Commission (NRC) Order EA-03-009 for St. Lucie Unit 1, pursuant to the procedure specified in Section IV, paragraph F of the Order. Relaxation Request No. 1 requested relaxation from the requirements specified in Section IV, paragraph C.(1)(a) for the area of the reactor pressure vessel (RPV) head surface that is inaccessible for visual inspection. Relaxation Request No. 2 requested relaxation from the requirements specified in Section IV, paragraph C.(1)(b)(i) for the RPV head penetration nozzles for which ultrasonic testing requirements cannot be completed as required.

On February 20, 2004, the NRC issued the First Revised Order EA-03-009, which revised requirements for bare metal visual inspections and penetration nozzle nonvisual inspections. By letter dated March 23, 2004, FPL confirmed its continued need for relaxation from inspection requirements in Section IV, paragraphs C.(5)(a) and C.(5)(b)(i) of the First Revised Order.

In conference calls on April 2 and April 4, 2004, the NRC staff and FPL discussed the results of the head inspections and the status of the NRC staff's review. FPL indicated that it had successfully overcome anticipated obstacles to completing the required bare metal visual inspection and by letter dated April 6, 2004, FPL withdrew Relaxation Request No. 1. Therefore, the NRC staff plans no further action on Relaxation Request No. 1. In the April 6, 2004, letter, FPL also modified Relaxation Request No. 2 and provided additional information in letters dated April 8 and April 13, 2004.

The NRC staff has reviewed and evaluated the information provided in support of Relaxation Request No. 2 and has found that FPL has demonstrated good cause for the requested relaxation. FPL has demonstrated that compliance with the First Revised Order would result in hardship without a compensating increase in the level of quality and safety. Therefore, pursuant to Section IV.F of the First Revised Order and Title 10, *Code of Federal Regulations*, Section 50.55a(a)(3), the NRC staff approves Relaxation Request No. 2 for one 18-month operating cycle, commencing with startup from the spring 2004 (SL1-19) refueling outage, and authorizes the proposed alternatives to item IV.C.(5)(b)(i) with respect to ultrasonic testing of RPV head penetration nozzles at St. Lucie Unit 1, subject to the condition outlined in the

conclusion section of the enclosed safety evaluation. Your April 13, 2004, letter agreed to this condition.

Further details on the bases for the NRC staff's conclusions are contained in the enclosed safety evaluation. If you have any questions regarding this issue, please contact Brendan Moroney at (301) 415-3974.

Sincerely,
/RA/

Edwin M. Hackett, Director
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-335

Enclosure: Safety Evaluation

cc: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELAXATION REQUEST NOS. 1 AND 2

FLORIDA POWER AND LIGHT COMPANY

ST. LUCIE UNIT 1

DOCKET NO. 50-335

1.0 INTRODUCTION

By letter dated November 21, 2003, Florida Power and Light Company (FPL) submitted two requests for relaxation from the inspection requirements of the U.S. Nuclear Regulatory Commission (NRC) Order EA-03-009 for St. Lucie Unit 1, pursuant to the procedure specified in Section IV, paragraph F of the Order. Relaxation Request No. 1 requested relaxation from the requirements specified in Section IV, paragraph C.(1)(a) for the area of the reactor pressure vessel (RPV) head surface that is inaccessible for visual inspection. Relaxation Request No. 2 requested relaxation from the requirements specified in Section IV, paragraph C.(1)(b)(i) for the RPV head penetration nozzles for which ultrasonic testing (UT) cannot be completed as required.

On February 20, 2004, the NRC issued the First Revised Order EA-03-009, which revised requirements for bare metal visual inspections and penetration nozzle nonvisual inspections. By letter dated March 23, 2004, FPL confirmed its continued need for relaxation from inspection requirements in Section IV, paragraphs C.(5)(a) and C.(5)(b)(i) of the First Revised Order.

In conference calls on April 2 and April 4, 2004, the NRC staff and FPL discussed the results of the head inspections and the status of the NRC staff's review. FPL indicated that through the development of new tooling and use of mock-ups in preparing for the outage, it had successfully overcome anticipated obstacles to completing the required bare metal visual inspection. By letter dated April 6, 2004, FPL withdrew Relaxation Request No. 1, and the NRC staff plans no further action on this request.

In the April 6, 2004, letter, FPL also modified Relaxation Request No. 2 regarding UT inspection and provided additional information in letters dated April 8 and April 13, 2004. This Safety Evaluation addresses Relaxation Request No. 2.

2.0 REGULATORY EVALUATION

The First Revised NRC Order EA-03-009, issued on February 20, 2004, requires specific examinations of the reactor pressure vessel (RPV) head and vessel head penetration (VHP) nozzles of all pressurized-water reactor plants. Section IV, paragraph F, of the First Revised Order states that requests for relaxation of requirements associated with specific penetration

nozzles will be evaluated by the NRC staff, using the procedure for evaluating proposed alternatives to the American Society of Mechanical Engineers (ASME) Code in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3). Section IV, paragraph F, of the First Revised Order states that a request for relaxation regarding inspection of specific nozzles shall address the following criteria: (1) the proposed alternative(s) for inspection of specific nozzles will provide an acceptable level of quality and safety, or (2) compliance with this First Revised Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For St. Lucie Unit 1, and similar plants determined to have a high susceptibility to primary water stress corrosion cracking (PWSCC) in accordance with Section IV, paragraph A and B, of the First Revised Order, the following nonvisual inspections are required to be performed every refueling outage in accordance with Section IV, paragraph C.(5)(b):

> (b) For each penetration, perform a nonvisual NDE [nondestructive examination] in accordance with either (i), (ii), or (iii):
>
> (i) Ultrasonic testing of the RPV head penetration nozzle volume (i.e., nozzle base material) from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 2 inches below the lowest point at the toe of the J-groove weld on a horizontal plane perpendicular to the nozzle axis (or the bottom of the nozzle if less than 2 inches [see Figure IV-1]); OR from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 1.0-inch below the lowest point at the toe of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) and including all RPV head penetration nozzle surfaces below the J-groove weld that have an operating stress level (including all residual and normal operation stresses) of 20 ksi tension and greater (see Figure IV-2). In addition, an assessment shall be made to determine if leakage has occurred into the annulus between the RPV head penetration nozzle and the RPV head low-alloy steel.
>
> (ii) Eddy current testing or dye penetrant testing of the entire wetted surface of the J-groove weld and the wetted surface of the RPV head penetration nozzle base material from at least 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 2 inches below the lowest point at the toe of the J-groove weld on a horizontal plane perpendicular to the nozzle axis (or the bottom of the nozzle if less than 2 inches [see Figure IV-3]); OR from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 1.0-inch below the lowest point at the toe of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) and including all RPV head penetration nozzle surfaces below the J-groove weld have an operating stress level (including all residual and normal

operation stresses) of 20 ksi tension and greater (see Figure IV-4).

(iii) A combination of (i) and (ii) to cover equivalent volumes, surfaces, and leak paths of the RPV head penetration nozzle base material and J-groove weld as described in (i) and (ii). Substitution of a portion of a volumetric exam on a nozzle with a surface examination may be performed with the following requirements:

1. On nozzle material below the J-groove weld, both the outside diameter and inside diameter surfaces of the nozzle must be examined.

2. On nozzle material above the J-groove weld, surface examination of the inside diameter surface of the nozzle is permitted provided a surface examination of the J-groove weld is also performed.

Footnote 3 of the First Revised Order provides specific criteria for examination of repaired VHP nozzles.

3.0 TECHNICAL EVALUATION

3.1 First Revised Order Requirements for which Relaxation is Requested

The licensee has requested relief from Section IV, paragraph C.(5)(b)(i) of the First Revised Order, which states that the following inspections be performed every refueling outage for high susceptibility plants similar to St. Lucie Unit 1:

(i) Ultrasonic testing of the RPV head penetration nozzle volume (i.e., nozzle base material) from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 2 inches below the lowest point at the toe of the J-groove weld on a horizontal plane perpendicular to the nozzle axis (or the bottom of the nozzle if less than 2 inches [see Figure IV-1]); OR from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 1.0-inch below the lowest point at the toe of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) and including all RPV head penetration nozzle surfaces below the J-groove weld that have an operating stress level (including all residual and normal operation stresses) of 20 ksi tension and greater (see Figure IV-2). In addition, an assessment shall be made to determine if leakage has occurred into the annulus between the RPV head penetration nozzle and the RPV head low-alloy steel.

The specific relaxation requested is identified below.

3.2 Licensee's Proposed Alternative Method

The licensee seeks relaxation from the First Revised Order EA-03-009, where inspection coverage for NDE, including UT, eddy current testing, and dye penetrant testing (PT) is limited by inaccessible areas of Control Element Drive Mechanism (CEDM) penetration nozzles.

The licensee proposes to meet the First Revised Order requirements, or to examine each CEDM nozzle to the maximum extent possible. It proposes to inspect a minimum of 0.75 inch above the J-groove weld on the uphill side to a minimum of 0.75 inch below the weld on the downhill side. The 0.75-inch limit bounds all but five CEDM penetrations, based on a review of the fall 2002 refueling outage (SL1-18) inspection data. The new, improved UT tooling configuration deployed during the St. Lucie Unit 1 spring 2004 refueling outage (SL1-19) could bound all CEDM penetrations. The licensee states that if the proposed level of coverage cannot be obtained at all penetrations, the specific situations will be evaluated and a revised relaxation request will be submitted, or modifications will be implemented to obtain the proposed coverage.

3.3 Licensee's Basis for Relaxation

The licensee stated that, pursuant to First Revised Order EA-03-009, Section IV.F(2), compliance with the Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The licensee stated that the circumferential blade UT probe used at St. Lucie Unit 1 has been demonstrated for detection of circumferential, off-axis, and axial flaws. This probe has separate transducers (50° longitudinal time of flight diffraction) for sending and receiving the UT signal. The transducers are arranged vertically, approximately 0.787 inch apart. The scanning process requires both transducers to be in contact with the inside diameter (ID) surface of the nozzle. Based on the nominal arrangement of the transducers, the portion that cannot be scanned is a triangular portion extending from the bottom of the nozzle upward for a distance of approximately 0.30 inch (half the transducer separation), measured on the nozzle outside diameter (OD). The nozzle ID surface is fully interrogated by the UT transducer to the end of the nozzle.

The licensee indicated that changing the configuration from a circumferential probe to an axial probe arrangement was not feasible. The circumferential probe was chosen because of its ability to detect and size axial, off-axis and circumferential flaws, its robustness, and its ability to obtain more consistent surface contact than an axial probe arrangement. The axial probe has limitations due to element size that prohibit interrogation to the bottom of the nozzle with no increased coverage capabilities for areas of distortion above the weld.

Another probe arrangement considered was a rotating UT probe, which is capable of interrogating all the material from 2 inches above the weld to the bottom of the nozzles in penetrations that are not open, but would require removal and replacement of the permanently installed CEDM nozzle thermal sleeves. The removal and reinstallation of two thermal sleeves during the SL1-18 outage inspection resulted in approximately 4.8 man-rems of exposure. This method of examination would be time and dose intensive without a commensurate increase in safety.

The licensee stated that manual PT examinations of the missed OD areas of the penetration base material would be time and dose intensive without a compensating increase in safety. The dose estimate to perform manual PT surface examination of the nozzles examined by the blade-probe UT would be approximately 19 man-rems, based on the actual dose rates and actual surface examinations of the vent line experienced at St. Lucie Unit 2. The PT examination of the remaining 69 penetration base material OD would result in excessive dose without a commensurate increase in safety. The installed thermal sleeves prevent manual PT of the ID surfaces.

The licensee is requesting a reduction of the examination coverage area based on a flaw tolerance analysis approach. The licensee indicated that this approach will provide an acceptable level of quality and safety with respect to reactor vessel structural integrity and leak integrity.

3.4 Evaluation

The NRC staff's review of this request was based on criterion (2) of paragraph F of Section IV of the First Revised Order, which states:

> Compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The phenomenon of concern is PWSCC, which typically initiates in the areas of highest stress. The area of CEDM penetrations that has the highest residual stress is the area adjacent to the J-groove attachment weld. Therefore, it is most likely that PWSCC will initiate in an area adjacent to the J-groove attachment weld.

In its supplemental letter dated April 6, 2004, the licensee submitted a revised request for relaxation from the First Revised Order requirement to examine to the base of each CEDM nozzle. In its April 8, 2004, response to the NRC staff's Request for Additional Information, the licensee indicated that it had modified its scan height by positioning the bottom axial probe between the nozzle and guide sleeve to achieve the scanning requirements of the First Revised Order. Since scanning requirements below the J-groove weld were met, the NRC staff concludes that relaxation of this First Revised Order requirement is no longer necessary.

The Electric Power Research Institute (EPRI) Materials Reliability Program (MRP) report MRP-95, "Materials Reliability Program Generic Evaluation of Examination Coverage Requirements for Reactor Pressure Vessel Head Penetration Nozzles," dated September 2003, shows that both axial and hoop stress levels in this region drop below 20 ksi for all the CEDM nozzles with the exception of the nozzle at the 0° location. The licensee expected the UT examination to extend 1 inch above the weld. However, in its April 2, 2004, conference call with the licensee, the NRC staff indicated that it requires that the licensee provide plant specific stress level data showing the stress levels are conservative in the areas not examined in accordance with the requirements of the First Revised Order.

In its supplemental letter dated April 6, 2004, the licensee provided the results of its UT examination of all the CEDM nozzles completed during the SL1-19 outage. The coverage requirements of the First Revised Order were met with the exception of the 17 nozzles listed in the table below.

Nozzle Use	Nozzle Angle °	Pen #	Above Weld Root Uphill Side	Arc < 2.0" Above Weld Root (Degrees)	Circumferential Coverage (Degrees)	Examined to End of Nozzle
CEDM	35.6	35	1.65	89.00	360	Yes
CEDM	25.3	24	1.75	77.70	360	Yes
CEDM	42.5	62	1.75	67.00	360	Yes
CEDM	11.0	6	1.80	12.00	360	Yes
CEDM	22.4	12	1.80	47.00	360	Yes
CEDM	29.1	26	1.80	64.00	360	Yes
CEDM	35.6	38	1.80	75.00	360	Yes
CEDM	42.5	60	1.80	54.00	360	Yes
CEDM	35.6	34	1.85	21.00	360	Yes
CEDM	42.5	63	1.85	48.00	360	Yes
CEDM	23.9	14	1.90	17.00	360	Yes
CEDM	25.3	19	1.90	51.00	360	Yes
CEDM	25.3	25	1.90	27.00	360	Yes
CEDM	29.1	32	1.90	21.00	360	Yes
CEDM	29.1	33	1.90	48.00	360	Yes
CEDM	25.3	23	1.95	9.00	360	Yes
CEDM	29.1	28	1.95	60.00	360	Yes

In addition to the inspection results provided above in its April 6, 2004, transmittal, the licensee provided hoop stress plots specific to the nozzle angles of 0°, 29.1°, 37.1°, and 42.5° for St. Lucie Unit 1. The plant specific analysis in Section 5.1 of Westinghouse WCAP-15945, "Structural Integrity Evaluation of Reactor Vessel Upper Head Penetrations to Support Continued Operation: St. Lucie Unit 1," dated September 2002, indicates that these nozzle angles bound the CEDM penetration angles in the St. Lucie Unit 1 reactor vessel head. The highest stress results were associated with the 0° CEDM nozzle angle, with an inspection distance 1.11 inches (ID) and 0.56 inch (OD) from the top of the J-groove weld corresponding to 20 ksi and 12 ksi, respectively. From the inspection data provided above, the minimum distance from the top of the J-groove weld obtained was 1.65-1.95 inches with a corresponding hoop stress value less than 10 ksi. The NRC staff concludes that the hoop stresses in the area of the CEDM nozzle where UT examination results were not obtained in compliance with the First Revised Order, are sufficiently low such that cracking due to PWSCC is unlikely.

St. Lucie Unit 1 has material with a yield strength from 39.5 ksi to 54 ksi, which suggests that the lower bound for PWSCC initiation would be 27 ksi at 70 percent yield. Since the data provided by the licensee indicates that the 1.65 inches minimum scan distance above the J-groove weld has been accomplished, which correlates to tensile stresses less than 10 ksi, the NRC staff concludes that the material provides an additional margin of conservatism.

The licensee's analysis in WCAP-15945, Rev. 1 used the crack growth formula in EPRI MRP report MRP-55, "Material Reliability Program (MRP) Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick Wall Alloy 600 Material (MRP-55), Revision 1." The NRC staff has not yet made a final determination on the acceptability of this industry report. Therefore, should the NRC staff determine the crack growth formula used by the licensee to be unacceptable, the licensee will be required to revise its analysis to incorporate an acceptable crack growth formula as described below.

> If the NRC staff finds that the crack-growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the First Revised Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

In its supplemental letter dated April 13, 2004, the licensee agreed to the above condition.

Based upon the information above, the NRC staff finds that the licensee's proposed alternative examination is acceptable as it provides reasonable assurance of the structural integrity of the RPV head, VHP nozzles and welds. Further inspections to comply with the First Revised Order requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

4.0 CONCLUSION

The NRC staff concludes that the licensee's proposed alternative UT examination of the 17 CEDM nozzles from 1.65 inches above the J-groove weld, and to the maximum extent practical, supported by plant-specific inspection results and hoop stress analyses for bounded nozzles, provide reasonable assurance of the structural integrity of the RPV head, VHP nozzles and welds. Further inspections of these VHP nozzles in accordance with Section IV, paragraph C.(5)(b)(i), of the First Revised Order EA-03-009 would result in hardship without a compensating increase in the level of quality and safety. Therefore, for good cause shown, pursuant to Section IV, paragraph F, of the First Revised Order EA-03-009, the NRC staff authorizes the proposed alternative inspection at St. Lucie Unit 1 for one 18-month operating cycle, commencing with the startup from the SL1-19 refueling outage, subject to the following condition:

> If the NRC staff finds that the crack-growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the First Revised Order dated February 20, 2004, within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis

shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

Principal Contributor: Timothy Steingass, NRR

Date: April 15, 2004